

# PATENT SPECIFICATION

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## (54) LIQUID CRYSTAL DISPLAY DEVICES

(71) I, SECRETARY OF STATE FOR DEFENCE, London, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to liquid crystal display devices in which information is selectively displayed and which relies on reflected light to product a visible image.

A device relying on reflected light has the advantage that it is visible under bright ambient light, e.g. sun-light. This contrasts with displays in which light is transmitted through a liquid crystal display for view by an observer; such displays are difficult to use in bright ambient light.

According to this invention a liquid crystal display device comprises in series a linear polariser, a twisted nematic liquid crystal cell arranged to rotate linearly polarised light through 35° to 55° and including shaped electrodes arranged both sides of a layer of liquid crystal, a quarter wave plate, and a reflector capable of substantially preserving polarisation and means for applying a suitable voltage across the layer of liquid crystal between the electrodes, the arrangement being such that in the absence of the suitable voltage to the device it appears as a uniform colour or shade and upon application of the suitable voltage to the electrodes the shape of the electrodes appears in a contrasting colour or shade to the background.

The cell is preferably arranged to rotate light by 45° since this provides maximum contrast.

A twisted nematic liquid crystal cell may be formed by enclosing a thin e.g. 12 μm thick, layer of liquid crystal material between glass plates. Transparent electrodes of suitable shape are deposited, prior to assembly, on the glass face in contact with the liquid crystal; the electrode shape is achieved by selective etching of a uniform coating. To achieve a cell capable of rotating linearly polarised light through 45° the inner surface of the

plates, i.e. those to be in contact with the liquid crystal, are treated to align molecules in the liquid crystal adjacent the plates. Such a treatment may be unidirectional rubbing of the inner surface with a lint free cloth, or oblique evaporation of e.g. Silicon monoxide, or Magnesium Fluoride as described in U.K. Patent Serial No. 1,454,296 onto the inner surface. On assembly the two plates are arranged with the direction of rubbing on one plate at 45° to that of the other plate.

Suitable liquid crystals are as described in U.K. Patent Serial No. 1,433,130 or mixtures of PEBA B[p-[(p-Ethoxybenzylidene)amino]-benzo-nitrile] and MBBA[N-(p-Methoxybenzylidene)-p-butylaniline].

Application of a suitable voltage typically about 5V across the liquid crystal layer causes a rotation of molecules in the liquid crystal and the cell no longer rotates linearly polarised light but transmits light freely without rotation. Removal of the voltage allows the liquid crystal material to revert to its original condition.

Circularly polarised light may be obtained by passing white light first through a linear polariser and then a quarter wave plate arranged with its principal (fast or slow) axis at 45° to the preferred optical axis of the polariser.

The invention will now be described, by way of example only, with reference to the drawings accompanying the Provisional Specification in which:—

Figure 1 is a sectional side view of one form of the invention.

Figure 2 is a front view of one form of display showing alpha numeric characters.

As shown in Figure 1 but not in correct proportions, a display device 1 includes, in series, a polariser 2, a twisted nematic liquid crystal cell 3, a quarter wave plate 4, and a reflector 5. The polariser has its outersurface treated to make it non-reflecting.

The cell 3 is arranged to rotate linearly polarised light through 45° and is constructed as described above; a layer 6 of

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5. A device as claimed in any one of Claims 1 to 4 wherein the quarter wave plate has its principal (slow or fast) axis arranged at  $45^\circ$  to the axis of polarisation of the polariser. 20
6. A device as claimed in any one of Claims 1 to 4 wherein the quarter wave plate has its principal (slow or fast) axis arranged parallel to the axis of polarisation of the polariser. 25
7. A device as claimed in any one of Claims 1 to 4 wherein the quarter wave plate has its principal (slow or fast) axis arranged perpendicular to the axis of polarisation of the polariser. 30
8. A device as claimed in any one of Claims 1 to 7 wherein the reflector is a mirror.
9. A device as claimed in any one of Claims 1 to 7 wherein the reflector is an aluminium coated reflector.
10. A device as claimed in any one of Claims 1 to 9 wherein the electrodes are arranged for displaying alpha numeric characters.
11. A liquid crystal display device constructed arranged and adapted to operate substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

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Agent for the Applicant.

Reference has been directed in pursuance of Section 8 of the Patents Act 1949, to Specification No. 1,390,925.

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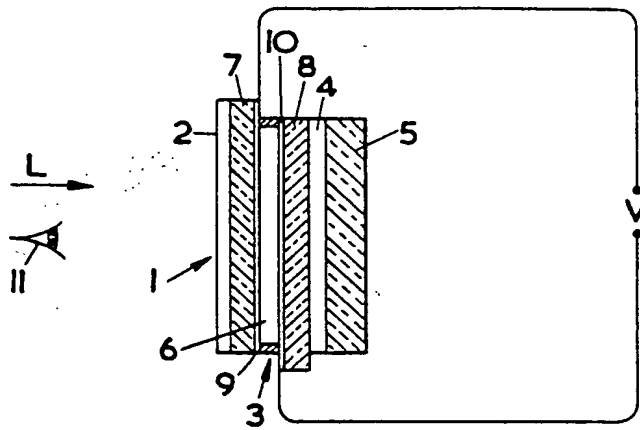


FIG. 1.

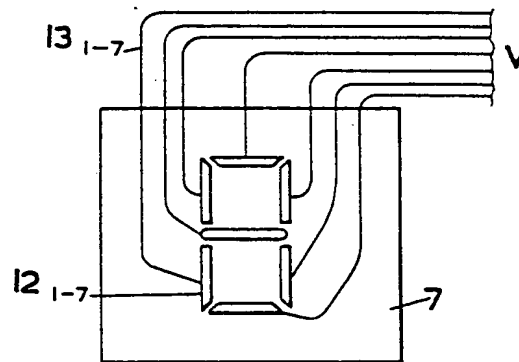


FIG. 2.

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